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Name of the Department	:	Physics
Name of the Course	:	B. Sc. (H) Physics – CBCS – NC
Semester	:	I
Name of the Paper	:	Mathematical Physics I
Unique Paper Code	:	32221101
Question Paper Set Number	:	A
Maximum Marks	:	75

Instruction for Candidates

1. Attempt **FOUR** questions in all.
2. All questions carry equal marks.

1. Solve the following first order differential equations

- **a.** $(2x + 3y)dx + (y - x)dy = 0$
- **b.** $(x - 2)\frac{dy}{dx} = y + 2(x - 2)^3$
- **c.** $(x^2 + y^2)dy - xy\,dx = 0$
- **d.** A machine produces 1% defective components. If the random variable X is the number of defective components in production of 50 components, then find the probabilities that X takes the value 2.

2. Solve the following second order differential equations

- **a.** $(D^2 - 5D + 6)y = e^x$
- **b.** $(D^2 - 3D + 2)y = \sin 2x$
- **c.** $(D^2 + 16)y = \sin x$ (Use the method of variation of parameters)

3. Find the constants a and b so that the surface $ax^2 - byz = (a + 2)x$ will be orthogonal to the surface $4x^2y + z^3 = 4$ at the point $(1, -1, 2)$.

Show that $\vec{E} = \frac{\vec{r}}{r^2}$ is irrotational. Find ϕ such that $\vec{E} = -\nabla\phi$ and such that $\phi(a) = 0$ where a>0.

4. Is there a differentiable vector function $\vec{V}$ such that,

$$\nabla \times \vec{V} = \vec{r}$$
$$\nabla \times \vec{V} = 2\hat{\imath} + \hat{\jmath} + 3\hat{k}$$

If yes, then find $\vec{V}$.
Find the value of $\nabla^2 \ln r$

5. Verify Green's theorem in the plane for $\oint (y - \sin x)\,dx + \cos x\,dy$, where C is the triangle formed by points (0, 0), $(\frac{\pi}{2}, 0)$ and $(\frac{\pi}{2}, 1)$.

$$\iiint_V \frac{dV}{r^2} = \iint_S \frac{\vec{r} \circ \hat{n}}{r^2} dS$$

6. Derive an expression for $\nabla \times \vec{A}$ in orthogonal curvilinear coordinates.
Evaluate $\iint \vec{A}.\hat{n}\, dS$, where $\vec{A} = z\hat{\imath} + x\hat{\jmath} - 3y^2z\hat{k}$ and S is the surface of the cylinder $x^2 + y^2 = 16$ included in the first octant between $z = 0$ to $z = 5$.

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